PROGRESS REPORT

GRAY-WOODED SOILS SUBSTATION

ATHABASCA, ALBERTA

1947-1958

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Experimental Farm, Lacombe, Alberta

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Roger Duhamel, F.R.S.C., Queen's Printer and Controller of Stationery, Ottawa, ...

INTRODUCTION

The Athabasca Substation was established in 1947. It was one of four such stations, two in Alberta and two in Saskatchewan, established by the Experimental Farms Service, Canada Department of Agriculture, to carry out extensive investigations of crop production problems on gray-wooded soils. It is on the farm of Mr. Joe Eherer, Section 10-66-23-W4th, four miles west of Athabasca, Alberta, and is under the supervision of the staff of the Experimental Farm at Lacombe.

It is unnecessary to stress the importance of the vast area of gray-wooded soils in Western Canada. They extend across the northern parts of the prairie provinces and of British Columbia and in the eastern foothills of the Rockies. These soils were the last major soil areas to be settled and most of the potential agricultural land yet undeveloped is in this soil group.

The problems of production on the gray-wooded soils are complicated by the variabilities of type and structure of the soils themselves, their relatively low contents of fertility, fibre, and organic matter, and their susceptibility to wind and water erosion. Some are also subject to "baking", which makes establishment of crop stands difficult. Most of them can be made economically productive and the results of further research will undoubtedly contribute to wider and fuller use of these soils in the future.

Investigations at the Athabasca Substation include rotation and fertilizer studies, adaptability tests with forage and cereal crops, pasture studies, and a limited amount of testing of horticultural crops. Farm management studies have also been undertaken. This report summarizes the findings of these investigations during the years 1947 to 1958.

METEOROLOGY

The climate varies throughout the gray-wooded soil zone in Alberta. In general, precipitation in this area increases slightly from east to west and decreases from south to north. Lower precipitation in the northern areas is offset to some extent by lower evaporation. Similarly, slightly cooler mean summer temperatures are compensated for by increased day length. The length of the frost-free period also varies widely throughout the area and is the major limiting factor in crop production.

Table 1 - Precipitation as Inches of Rainfall - 1948 - 1958.

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total	Growing Season April May June July
1948	1.00	1.70	3.00	2.61	1.25	0.23	1.37	0.60	0.60	0.15	0.01	0.23	12.75	5.46
1949	0.00	0.60	0.50	1.85	0.75	1.76	3.01	5.08	1.77	0.47	0.51	1.00	17.30	7.37
1950	0.06	0.12	0.10	0.01	0.34	0.34	1.61	1.76	0.77	0.75	2.96	0.80	9.62	2.30
1951	1.30	1.00	0.40	0.56	2.58	0.95	5.55	2.15	2.06	1.35	1.63	0.65	20.18	9.64
1952	1.70	0.66	0.58	0.04	1.16	4.95	1.97	0.65	1.32	0.44	0.00	0.00	13.47	8.12
1953	2.65	0.30	0.55	1.72	2.91	3.07	4.72	4.73	0.41	0.42	2.30	1.80	25.58	12.42
1954	0.40	0.09	0.90	0.40	4.40	2.61	8.39	6.32	2.92	0.45	0.00	0.79	27.67	15.80
1955	0.29	1.60	2.30	2.60	1.78	3.37	4.41	2.56	5.08	1.92	1.17	2.00	29.08	12.16
1956	1.20	1.30	0.54	0.12	1.50	2.66	1.14	1.64	2.02	1.54	0.45	0.50	14.61	5.42
1957	0.30	0.52	1.30	0.13	2.47	1.43	5.06	3.69	2.29	2.55	1.50	0.80	22.04	9.09
1958	0.40	1.40	0.40	0.03	0.29	1.20	0.51	0.25	5.43	0.45	0.70	0.50	11.56	2.03
11-Year Average													18.53	

Records at the Athabasca Substation (Table 1) show that the annual precipitation varied from a low of 9.62 inches in 1950 to a high of 29.08 inches in 1955 and that the 11-year average was 18.53 inches. Notable extremes within the growing seasons also were experienced. In 1950 and 1958, less than three inches of rainfall were received during the growing months whereas in 1953, 1954 and 1955 the amount was over twelve inches.

The dates of frost that caused crop damage were recorded. The earliest fall frost occurred August 18, 1950 while the latest was September 20, 1953. Frost damage may vary because of drainage of cold air to low-lying areas. Thus, it may be possible to mature wheat on high ground whereas only early-maturing barley or oats might survive on low-lying land such as peat flats.

DESCRIPTION OF SOILS

A soil survey of the Athabasca area has not been made to date. However, the section of land on which the Substation is located was surveyed and, in addition, a detailed survey was made of the experimental area in 1953. A number of soil types were mapped on the Substation. Breton loam is the most important as most of the farmed land is of this type. It is a gray-wooded soil on the higher, better-drained areas. Low-lying areas which occur in conjunction with Breton loam were defined as Fair Drained Associates and Poorly Drained Associates. These occur fairly often as the topography is gently undulating to humpy and this causes numerous low areas. Kenzie and Eaglesham organic soils (peat) occupy a considerable area of low-lying land, often flooded. Associated with the peat soils at the outer edges is a Meadow Associate which is a mixture of well-decomposed peat and mineral matter.

All the soil types named above were identified in the experimental plot area. It was found that the area was divided into two fairly well defined parts. One-half was relatively level with good drainage, few low-lying areas and was largely gray-wooded earth, Breton loam. The other half was more rolling with numerous depressions and knolls and contained all of the soil types named above in some degree. Thus, while one-half of the test area was almost entirely one soil type, Breton Loam, the other half was variable and contained many. To interpret correctly the results of fertility work at the Substation it is necessary to keep in mind the variable nature of the soil.

SOIL FERTILITY STUDIES

Shortly after the Substation was established tests were initiated to investigate the problem of soil fertility. Several of the tests were also carried at other gray-wooded soil localities. The information obtained from the small plot fertility tests at Athabasca was of little value largely because these tests were on that part of the plot area which contained numerous soil types. No further discussion of these small plot tests of soil fertility is given.

Plant Food Deficiency Study

About one-half the experimental area was occupied by a test of both fertilizers and rotations. The area was divided into six strips of equal width running the full length of the field. Each strip was subdivided into 24 plots, each about 50 x 70 feet. Thus, one-half of the plots were on uniform soil, while the other half were on variable soil.

Basically, the test consisted of two 3-year rotations on which eight fertilizer treatments and four checks (untreated plots) were superimposed in duplicate. The rotations were as follows:

	First year - Wheat
Grain rotation	Second year - Oats
	Third year - Fallow
	First year - Wheat-Seeded down to Altaswede red clover
Legume rotation	Second year - Altaswede hay
	Third year - Green manure, fallow

While these short term rotations have no particular application in the district as practical farm rotations they were used to obtain information on fertilizers, rotations and their interaction, in the shortest possible time. This information may then be applied in setting up rotations of more practical value to the area.

Each year at seeding, the fertilizer treatments were broadcast on the first-year grain crop (wheat) of both rotations. These treatments were applied in amounts to supply nitrogen, phosphorus, potassium, and sulphur singly or in combinations as shown in Table 2.

Table 2 - Treatments, Rate Per Acre and Amount of Plant Nutrients Supplied By Each Treatment.

Treatment	Rate per Acre lb. or tons	Plant Nutrients-Pounds/Acre N	P_2O_5	K_2O	S
1. Manure	15 tons	150	75	150	10
2. Check (no treatment)					
3. Ammonium nitrate	50	16			
4. Sulphur	20				20
5. Check					
6. Ammonium sulphate	80	16			20
7. Triple superphosphate	45		20		
8. Check					
9. Ammonium phosphate 11-48-0 and Ammonium nitrate	45 and 36	16	20		
10. Ammonium phosphate 16-20-0 and sulphur	100 and 6	16	20		20
11. Check					
12. Ammonium phosphate 16-20-0 and potassium sulphate	100 and 40	16	20	20	20

The treatments and checks were laid out on the field strips in the order given in Table 2. Treatments 1 to 12 were on the uniform upper half of the test area while treatments 13 to 24 (duplicates of treatments 1 to 12) were on the variable lower half of the area. Thus it was possible to compare the effect of rotations and fertilizer treatments on the two soil areas.

A summary of the results of this test is given in Table 3. The yields from plots 1-12 (Breton loam) are separate from those of plots 13-24 (mixed soils) for each rotation. The four checks from each block of twelve are averaged in each case. All treatments containing sulphur also are averaged, these figures appearing at the bottom of the table.

The results of this experiment revealed the following:

I. <u>Productivity</u>

Lower inherent productivity of the Breton loam as compared to the mixed soils is apparent from the "check" yields of wheat in both rotations as well as by the legume hay and oat yields, the second-year crops in the two rotations.

Table 3 - Average Annual Yields of Wheat, Oats and Legume Hay from Fertilizer Treatments on a Grain Rotation and a Legume Rotation-1948-1957

Treatment	Rate per Acre lb.or tons	Direct Effect of Fertilizer Application				Residual Effect of Fertilizer Application			
		Grain Rotation Wheat after fallow Bu/A		Legume Rotation Wheat after fallow Bu/A		Grain Rotation Oats after Wheat Bu/A		Legume Rotation Legume Hay after WheatT/A	
		10-yr. ave. plots 1-12	10-yr. ave. plots 13-24	10-yr. ave. plots 1-12	10-yr. ave. plots 13-24	8-yr. ave. plots 1-12	8-yr. ave. plots 13-24	7-yr. ave. plots 1-12	7-yr. ave. plots 13-24
Manure	15 T.	34.9	40.9	40.2	45.8	44.6	48.7	1.60	1.45
Ammonium nitrate	50	26.4	32.5	24.0	36.4	40.7	34.8	0.54	0.88
Sulphur	20	27.3	33.0	36.8	45.4	44.0	39.4	1.20	1.76
Ammonium sulphate	80	28.5	35.2	35.8	41.0	35.8	33.2	1.70	2.03
Triple superphosphate	45	26.7	31.2	31.6	38.8	29.9	41.5	0.81	1.32
Ammonium phosphate 11-48-0 and ammonium nitrate	45 36	32.1	37.7	34.2	39.3	33.1	37.6	1.01	1.21
Ammonium phosphate 16-20-0 and sulphur	100 6	31.1	36.0	41.8	42.0	41.1	35.5	1.58	1.76
Ammonium phosphate 16-20-0 and potassium sulphate	100 40	31.3	30.7	39.4	40.0	43.3	37.4	1.34	1.59
Average of 4 untreated plots	-	27.6	33.7	28.5	37.0	34.3	37.6	0.65	1.07
Average of all plots that received sulphur	-	29.6	34.0	38.4	42.1	41.0	36.4	1.46	1.78

Untreated plot yields from	Wheat, Bu/Acre Grain Rotation	Legume Rotation	Legume Hay, Tons/Acre Legume Rotation	Oats, Bu/Acre Grain Rotation
Mixed soils (plots 13-24)	33.7	37.0	1.07	37.6
Breton Loam (plots 1-12)	27.6	28.5	.65	34.3
Difference	6.1	8.5	.42	3.3

II. Fertilizer Response

A. Sulphur Fertilizers - Sulphur-containing fertilizer treatments on wheat in the grain rotation produced only slight yield responses on either soil type. Sulphur alone was no better than the check and with the addition of nitrogen as ammonium sulphate, or nitrogen and phosphorus as ammonium phosphate 16-20-0, only minor increases in yield resulted.

Treatment	Wheat, Bu. per acre - Grain rotation Breton loam	Mixed soils
Sulphur	27.3	33.0
Ammonium sulphate	28.5	35.2
Ammonium phosphate 16-20-0	31.1	36.0
Average of sulphur-containing treatments	29.6	34.0
Check - No fertilizer	27.6	33.7
Difference	2.0	0.3

B. Nitrogen-phosphorus fertilizers - Nitrogen alone or phosphorus alone, when applied to wheat resulted in little or no increase over the checks in either rotation. However, when combined they gave the highest yields of any of the chemical fertilizers on both the Breton loam and the mixed soils in the grain rotations. Combined, they were also more effective in the legume rotation than when used singly but were outyielded in all cases by any treatment containing sulphur.

Treatment	Wheat - Bushels per Acre Grain rotation Breton loam	Mixed soils	Legume rotation Breton loam	Mixed soils
Ammonium nitrate	26.4	32.5	24.0	36.4
Triple super phosphate	26.7	31.2	31.6	38.8
Ammonium phosphate 11-48-0 and Ammonium nitrate	32.1	37.7	34.2	39.3
Check - No fertilizer	27.6	33.7	28.5	37.0
Increase from N + P	4.5	4.0	5.7	2.3

III. Legume Effect

There was little increase in yields from the inclusion of a legume in the rotation. The yield of wheat (unfertilized) in the legume rotation was only slightly greater than in the grain rotation on either the Breton loam or the mixed soils.

Yields from untreated plots	Wheat, Bushels per Acre Breton loam	Mixed Soils
Legume rotation	28.5	37.0
Grain rotation	27.6	33.7
Difference	0.9	3.3

IV. Combined Effect of Sulphur-containing Fertilizers and Legumes

The greatest yield response from either the Breton loam or the mixed soils was obtained when sulphur-containing fertilizers were applied in the legume rotation.

Treatment	Wheat, Bushels per Acre Breton loam	Mixed soils
Sulphur-containing fertilizers in legume rotation	38.4	42.1
Untreated plots in the grain rotation	27.6	33.7
Difference	10.8	8.4

V. Degree of Response from the Combined Effect

The yield increase of wheat from sulphur-containing fertilizers in the legume rotation was more pronounced on the Breton loam than on the mixed soils. The increase obtained on the Breton loam was almost double (87 per cent) that obtained on the mixed soils.

Treatment	Wheat, Bushels per Acre - Legume Rotation Breton loam	Mixed Soils
Sulphur-containing fertilizers	38.4	42.1
Checks - No sulphur	28.5	37.0
Difference	9.9	5.1

VI. Residual Response

A. Legume Rotation - The sulphur-containing fertilizers applied to wheat (1st year of rotation) resulted in a large carry-over effect reflected in the yields of legume hay. This carry-over effect was more pronounced on the Breton loam than on the mixed soils. The increase in yield of hay on the Breton loam was 124.6% greater than the check whereas on the mixed soils it was 66.3% over the check.

Treatment	Hay, Tons per Acre - Legume Rotation Breton loam	Mixed soils
Sulphur-containing fertilizers	1.46	1.78
Checks - No sulphur	.65	1.07
Difference	.81	.71

B. Grain Rotation (Oats) - The residual response of oats in the grain rotation was variable. There was a fairly large carry-over effect from sulphur-containing fertilizers on the Breton loam whereas the direct effect on wheat was small. Both the direct and residual response from these treatments on the mixed soils were negligible. There was good response on both soil groups to the direct application of ammonium phosphate 11-48-0 plus ammonium nitrate but the residual response was nil. Thus there was great variation in the residual yield of oats and the correlation with yields of wheat in this rotation was poor in contrast to a fairly good correlation between the wheat and legume hay yields in the legume rotation.

Treatment	Grain, Bushels per Acre - Grain Rotation			
	Breton loam		Mixed soils	
	Wheat Direct Application	Oats Residual Effect	Wheat Direct Application	Oats Residual Effect
Sulphur-containing fertilizers	29.6	41.0	34.0	36.4
Checks - No sulphur	27.6	34.3	33.7	37.6
Difference	2.0	6.7	0.3	-1.2
Ammonium phosphate 11-48-0 and Ammonium nitrate	32.1	33.1	37.7	37.6
Check - No fertilizer	27.6	34.3	33.7	37.6
Difference	4.5	-1.2	4.0	0.0

VII. Organic Fertilizers

Manure was of great value for these soils. It produced an excellent yield response. In only one instance was the yield of grain from a plot treated with manure, whether residual or direct in either rotation, less than that from any of the chemical treatments. The carry-over effect of manure on the yield of hay was slightly less than that from some of the sulphur-containing fertilizers while on oats it produced the largest yields of any treatment. In addition, the organic matter from the manure improved the tilth and structure of these soils. This applies particularly to the Breton loam which is badly leached and lacking in organic matter.

SUMMARY - The results of this test revealed:

1. The Breton loam soil was less productive than the mixed soil types.
2. Sulphur-containing fertilizers applied in the grain rotation had little effect on yield.
3. Nitrogen and phosphorus were most effective when used together, irrespective of the rotation.
4. The addition of a legume alone to the rotation had little effect on yield.
5. Combining a legume crop and sulphur-containing fertilizers gave substantial yield increases.
6. A greater response to the combination of sulphur fertilizers and legumes was obtained on the Breton loam than on the mixed soil types.

7. There was good correlation between the residual response to fertilizers, as measured by legume hay, and the direct application, as measured on wheat.

8. The residual response to fertilizers as measured by the oats was variable and did not appear to establish any pattern.

9. Manure was the most consistently effective treatment whether applied directly or from its residual effect. It also had a favorable effect on the tilth and structure of the soil.

Figures 1 and 2 illustrate another possible benefit to be obtained from the use of sulphur-bearing fertilizers on a forage crop. The first picture was taken just prior to cutting the first-year hay crop. The second picture was taken the following year and is of the same two plots as in Figure 1. Altaswede red clover, is described as a biennial or shortlived perennial and is intermediate in winter hardiness between alfalfa and alsike clover. From these two pictures it is apparent that the sulphur-containing fertilizers had a beneficial effect on the ability of red clover to overwinter a second time as compared to the "no fertilizer" plots where the plants acted as biennials and died out after the production of one crop.

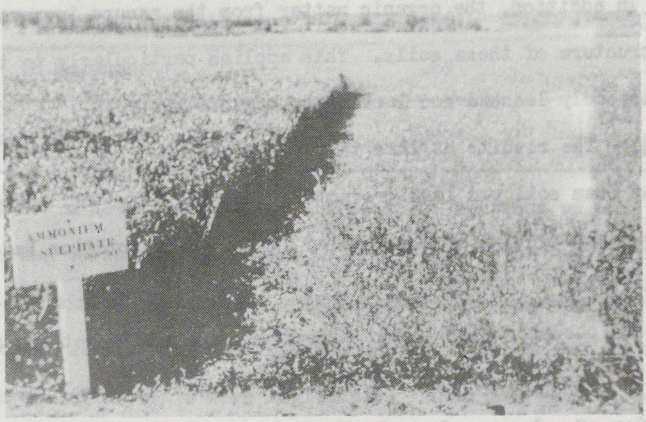

Figure 1 - The residual effect of a sulphur-bearing fertilizer on Altaswede red clover in the legume rotation. Left - Ammonium sulphate at 80 pounds per acre. Right - Check (no fertilizer).

Figure 2 - Comparison of the winter survival of second-year Altaswede red clover on an unfertilized plot (check), in the foreground, with a plot that received 80 pounds per acre ammonium sulphate, at left.

Study of Commercial Fertilizers as Sulphur Carriers

A test to determine the comparative value of several commercial fertilizers as sulphur carriers when applied to gray-wooded soils gave a limited amount of information. The yield data are contained in Table 4.

Table 4 - Comparison of a Number of Chemical Compounds as Sulphur Carriers

Treatment	Oats-Bu. per acre, 1953	Hay-Tons per acre, 1955
N.P.K. and Gypsum	74.8	2.35
N.P.K. and sodium sulphate	77.4	2.48
N.P.K. and ammonium sulphate	76.0	2.50
N.P.K. and potassium sulphate	76.6	2.44
N.P.K. and ammonium phosphate 16-20-0	76.1	2.49
Average of sulphate-sulphur treatments	76.2	2.45
N.P.K. and sulphur	69.3	1.16
N.P.K. and no sulphur	68.7	1.06
Check (no treatment)	55.6	0.88

Six sulphur-containing compounds were applied in such quantity as to supply 20 pounds of sulphur per acre. Nitrogen, phosphorus and potash were applied with each sulphur treatment to maintain a balance of these nutrients. A check and a treatment with nitrogen, phosphorus and potassium only were also included in the test. The plots were 6 x 18½ feet in size and were arranged in a randomized block design of four replicates.

Fertilizer applications were made on the first grain crop (oats, first year) and were repeated on the first hay crop (third year) in a 5-year mixed rotation consisting of two grain and three hay crops. The treatments were laid down on a comparatively uniform area of Breton loam soil.

While only two years results are presented for two different crops, the response to the fertilizer treatments was very similar in both cases. With both crops the complete fertilizer resulted in an increase in yield over the check. All sulphur treatments gave further increases with those from the sulphate forms being the largest. There was very little to choose between sodium sulphate, ammonium sulphate, potassium sulphate or ammonium phosphate sulphate (16-20-0) as the yields of grain and hay varied very little from the mean of the four treatments. The response from gypsum was slightly lower for both grain and hay than that from the four fertilizers just mentioned. The yields from the plots treated with elemental sulphur were markedly reduced from that of the other sulphur treatments and were only slightly larger than the yields from the N.P.K. treatment alone. As no residual yields are available the value of elemental sulphur as a fertilizer cannot be fully appreciated from the limited results presented. Elemental sulphur must first be converted by bacterial action to the sulphate form before it can be absorbed by plants, thus the effect of the direct application may be delayed until subsequent years.

FORAGE CROPS

Introduction Nurseries

The purpose of introduction nurseries is to provide preliminary information on new species or new varieties and strains of species. On the basis of their performance in the nurseries the species may be included in replicated plot trials with standard varieties used as checks to obtain comparative

yield data. The information obtain from nursery seedings includes factors of agronomic importance such as winter hardiness, resistance to winter crown rot, drought tolerance, quality of forage, hay and seed yields and general adaptability.

Two introduction nurseries were seeded at the Substation, the first in 1949 and the second in 1952. Included in these nurseries was a total of 84 species, varieties or strains made up of 4 annual grasses, 8 annual legumes, 41 perennial grasses, 25 perennial legumes and 6 biennial legumes. Three species, namely intermediate wheatgrass, Russian wild rye and broad-leaf birdsfoot trefoil, warranted further testing while two other species, big bluegrass and chickpea milk vetch, appeared quite promising and may be included in future hay or pasture tests.

Figure 3 - Intermediate wheatgrass grown in the forage nursery. One row was cut for hay, the other left for seed.

Grass-Legume Mixtures for Hay

Grass-legume mixture tests were seeded in 1949 and in 1952 to obtain comparative hay yield data on a number of grass and legume species when grown

alone and in mixtures. Yield data are given in Table 5. Hay yields were not obtained in 1950 due to dry weather and poor growth.

Table 5 - Average Yields in Tons per Acre, from Grass and Legume Species Grown Alone and in Mixtures for Hay

Species and Mixture	2-Year Ave. 1951-52	3-Year Ave. 1953-55
Timothy	.98	.94
Brome	.96	.95
Intermediate wheatgrass	-	1.06
Crested wheatgrass	.74	.95
Alfalfa	.80	1.74
Alfalfa and timothy	1.02	1.65
Alfalfa and brome	.95	1.74
Alfalfa and intermediate wheatgrass	-	1.84
Alfalfa and crested wheatgrass	.90	1.81
Red clover and timothy	1.04	-
Alsike clover and timothy	.82	-
Sweet clover and timothy	.73	1.01
Sweet clover and intermediate wheatgrass	-	1.23
Sweet clover and crested wheatgrass	.84	1.12
Sweet clover and brome	.80	1.39
Red clover and brome	-	1.54
Alsike clover and brome	-	1.34
Alfalfa, red clover and brome	-	1.80
Alfalfa, sweet clover and brome	-	1.67
Alfalfa, red clover and timothy	1.17	-
Alfalfa, sweet clover and timothy	.89	-
Alfalfa, timothy and creeping red fescue	.84	1.65
Alfalfa, timothy and Russian wild rye	.83	1.66
Alfalfa, brome and creeping red fescue	-	1.73
Alfalfa, brome and Russian wild rye	-	1.82

Observations and a study of the yearly yield data established fairly conclusively that brome and alfalfa should form the basis of any mixture for hay in this area. Two main factors caused this: First, a comparatively low

average annual precipitation with the occurrence of drought years; second, the susceptibility of many grasses and legumes to winter crown rot infection and winter injury.

Brome was superior in drought tolerance to any of the grasses. Similarly, the deep rooted legumes, alfalfa and sweet clover, were the only legumes that made any appreciable growth during dry years.

Susceptibility to winter crown rot and to winter injury affected the performance of the grasses and legumes to quite an extent. Timothy and creeping red fescue were severely attacked by winter crown rot, whereas intermediate wheatgrass and crested wheatgrass were moderately damaged. Brome suffered the least damage. None of the legumes possessed any marked resistance to winter crown rot. Alfalfa, however, was more winter hardy than alsike clover or red clover. Alfalfa killed out some but stands generally were satisfactory throughout the period whereas alsike clover and red clover almost disappeared from the mixtures by the third-crop year.

Regarding the grasses, brome provided the most uniform yields throughout the testing period. In general, timothy outyielded brome the first year but yields were reversed in succeeding years. Crested wheatgrass yielded well in wet years but poorly in dry years. Intermediate wheatgrass outyielded all other grasses alone and in mixture with alfalfa the first year but yields dropped rapidly thereafter. Creeping red fescue provided good bottom growth when added to brome and alfalfa or timothy and alfalfa. Of these two mixtures, the brome-alfalfa-creeping red fescue maintained much better ratios of the species throughout the testing period. Russian wild rye was difficult to establish in mixtures and was practically non-existent by the third crop year.

Alfalfa was by far the most suitable legume tested. Sweet clover increased yields during the first-crop year but, being a biennial, was short lived. Red clover was superior to alsike clover. However, both species, being short-lived perennials, thinned out badly after the second year. Their main value would be in short-term rotations or for seeding in forage mixtures on low-lying land subject to limited periods of flooding.

Grass-Legume Mixtures for Pasture

Yield data from two pasture tests, one seeded in 1948 and one in 1954, are given in Tables 6 and 7.

Table 6 - Three-year Average Yields of Forage in Pounds per Acre, from 1948 Seeding of Grasses and Legumes for Pasture - 1949-1951.

Grass Species	Mixture with Alfalfa	Alsike clover	Red clover	Average
Timothy	2720	2420	2060	2400
Brome	4300	3160	2740	3400
Crested wheatgrass	3100	3360	2360	2940
Kentucky bluegrass	2620	3160	3740	3173
Creeping red fescue	3480	2680	2500	2887
Red top	3160	3020	2180	2787
Timothy, brome and creeping red fescue	3540	2600	2580	2907
Check (no grass)	3060	3300	4400	3587
Average	3247	2962	2820	-

Table 7 - Three-year Average Yields of Forage in Pounds per Acre, from 1954 Seeding of Grasses and Legumes for Pasture - 1955-1957.

Grass Species	Grass Alone	Mixture with Birdsfoot trefoil	Alfalfa	Average
Timothy	1467	1398	2253	1706
Brome	1413	1383	2126	1641
Intermediate wheatgrass	1407	1330	2125	1621
Creeping red fescue	869	848	1365	1027
Russian wild rye	651	880	1258	930
Average	1161	1168	1825	-

In general, grass-alfalfa mixtures were more productive than grasses alone or in combination with other legumes. Brome-alfalfa, although not always the highest yielder, was the least affected by winter crown rot, winter injury or varying precipitation and thus provided the most uniform production. Timothy, alone or in mixtures, yielded exceptionally well the first year but yields dropped rapidly in succeeding years due to winter crown rot injury. This species produced an abundance of succulent forage in the early summer months of the first year which was particularly relished by the animals. However, it matured rapidly and was less palatable during the latter part of

the grazing season. In the second and third years this early-season flush of growth did not occur and the timothy lacked vigor throughout the season. Under these conditions the animals showed no preference for timothy over the other species. Intermediate wheatgrass and crested wheatgrass yielded well but were not grazed as closely as brome or timothy due to their somewhat coarser herbage. Creeping red fescue was very susceptible to winter crown rot and yielded poorly, although it provided excellent late fall pasture. Russian wild rye was hard to establish and a poor weed competitor. On the other hand it was readily grazed late in the fall. Kentucky bluegrass and red top did well only in low-lying areas.

Red clover and alsike clover outyielded alfalfa when grown in pure stands but, being short-lived perennials and lacking winter hardiness, these species thinned out rapidly after the second year. In any case, the pure stands of legumes were not satisfactory due to the occurrence of bloat in grazing livestock.

Figure 4 - Winter killing in creeping red fescue, the species most severely damaged in this manner.

Figure 5 - Comparison of the weed competition offered by Russian wild rye, left, and brome, right.

Alfalfa Variety Tests for Seed

The testing of eight varieties and strains of alfalfa was undertaken in cooperation with the Forage Crops Laboratory at Saskatoon, Saskatchewan in 1954. A hay test of these varieties was conducted at Lacombe and a seed test at Athabasca. The object of the tests was to compare several creeping-rooted synthetics, including Rambler, with standard varieties from the standpoint of forage and seed yields.

Table 8 - Percentage Stands and Yield Data of Alfalfa Varieties for Seed - 1956-1957.

	Percentage Stand	Seed Yield-Pounds per Acre		
Variety or Strain	1957	1956	1957	2-Year Average
Rhizoma	76.0	135	29	82
Grimm	90.3	110	26	68
Ladak	65.6	93	30	62
SC Syn. 3504F	70.8	49	23	36
Vernal	81.3	51	15	33
SC Syn. 34922 (Rambler)	78.8	32	18	25
Ranger	64.8	40	5	22
SC Syn. 3513F	65.0	19	14	16
L.S.D. (P = 0.05)		32	9	

In the seed test at Athabasca none of the varieties set seed in 1955. Seed yields during the next two years were exceptionally light (Table 8) and may be attributed to the lack of suitable pollinating insects. Rhizoma, Grimm and Ladak produced higher seed yields than Rambler or the other creeping rooted selections.

Figure 6 - Alfalfa Variety Seed Test showing Left to Right: Rhizoma, Rambler, Grimm, Rhizoma, Ranger, Vernal.

CEREAL CROPS

Variety tests with wheat, oats and barley were conducted continuously from 1947 to 1958. The information obtained from these, and similar tests at other locations, formed the basis for varietal recommendations for the gray-wooded soil zone in Alberta. The tests included at least one standard variety of each crop with which new strains or varieties were compared. As a result the varieties changed periodically. In general, the frost-free period was not long enough to allow late-maturing wheat varieties, such as Lake, to ripen. On the other hand late-maturing oats and barleys usually ripened and outyielded the early-maturing varieties. Both types have a place in a balanced cropping program in this district and were used successfully on the Substation.

Flax tests were discontinued due to the short frost-free period. The number of days to ripen flax and wheat were about the same but flax being

much more susceptible to frost injury was often killed by late-spring or early-fall frosts that did not cause damage to wheat.

On the basis of the variety trials, the varieties best adapted included Thatcher, Saunders and Selkirk wheat; Larain as an early-maturing oat or Eagle, Rodney and Garry as late-maturing oats; and Olli and Gateway as early barleys or Husky and Parkland as late barleys.

FARM MANAGEMENT STUDIES

Farm Rotation

Only one farm rotation (40 acre fields) was conducted in the general farm operations. It was a 6-year mixed farm rotation consisting of three grain crops followed by three hay or pasture crops. The third-year forage stand was broken after the hay was removed. The field was fallowed for the remainder of the year.

During the earlier years of this rotation fertilizers were used sparingly and only periodically. As time progressed it became evident that annual applications of fertilizers containing nitrogen, phosphorus and sulphur were beneficial. Hence in recent years all grain crops were fertilized with ammonium phosphate 16-20-0 at 60 pounds per acre. Hay crops also received more frequent applications of ammonium phosphate 16-20-0 or ammonium sulphate 21-0-0 at 100 pounds per acre. Barnyard manure, which was very beneficial to all crops, was used when available. The forage crop mixture consisted basically of brome and alfalfa. On the high land creeping red fescue was added to this mixture while on the low-lying land timothy and alsike were substituted for part of the brome and alfalfa.

This rotation was well adapted to the farm program. Excellent fertility was maintained as indicated by the yield data in Table 9. In addition, fibre and organic matter were built up to a point where the soil was fairly mellow and easy to work. No particular difficulty was encountered in recent years in establishing stands of forage or other crops due to soil baking. Furthermore, seeding down with the third consecutive grain crop was satisfactory both from the standpoint of obtaining forage crop stands and from grain yield. It is interesting to note that the highest hay yields were obtained from the second-year hay crops. Perennial weeds were not a problem. However

the rotation had little effect on the eradication of such annuals as wild oats, hemp nettle, and a more recent introduction, narrow leaved hawksbeard. Sound cultural practices, delayed seeding, and planting early-maturing cereals are still the best means of controlling these weeds.

Table 9 - Average Yields of Crops in a 6-Year Mixed Farm Rotation. 1951-1958.

Cropping Sequence	Crop	No. of Years Grown	Ave. Yield-Bu. or Tons/Acre
1st year grain	Wheat	8	36.5
2nd year grain	Wheat	1	17.5
	Oats	4	56.0
	Barley	3	37.8
3rd year grain seed down	Barley	8	31.2
1st year hay	Grass-legume mixture	8	1.60
2nd year hay	Grass-legume mixture	8	2.48
3rd year hay and break	Grass-legume mixture	7	1.10

Cost of Production

Factors considered in cost of production studies include charges for land, buildings, taxes, management, general farm equipment and expenses, field operations, hail insurance and materials, labor and interest on production costs. Some of these are fixed or basic charges while others vary from year to year.

Studies on the cost of producing wheat on fallow in the 6-year farm rotation (three grain and three hay) at the Substation were conducted from 1949 to 1958. The fallow in this rotation was a partial fallow after hay and break. A summary of the results is given in Table 10.

The cost of summerfallowing varied from $5.05 to $14.38 per acre and averaged $9.44 per acre. Wheat yields varied from 12.0 to 54.0 bushels per acre and averaged 34.8 bushels per acre. Cost of producing the wheat varied from $16.08 to $34.18 per acre and averaged $25.20 per acre or from $0.38 to $1.82 per bushel and averaged $0.72 per bushel. In general, as the yields increased the cost per bushel decreased.

Table 10 - Cost of Summerfallowing and Costs of Producing Wheat on Fallow - 1949-1958.

Year	Cost per Acre of Summerfallowing $	Yield Bu. per Acre	Cost per Acre $	Cost per Bushel $
1949	6.06	40.0	20.53	.51
1950	5.94	12.0	16.08	1.34
1951	5.05	54.3	20.41	.38
1952	14.38	37.0	18.40	.50
1953	9.58	41.0	29.04	.71
1954	11.41	25.0	28.50	1.15
1955	9.33	47.4	34.18	.72
1956	10.16	37.6	31.28	.83
1957	11.98	38.3	25.23	.66
1958	10.53	15.6	28.35	1.82
10-Year Average	9.44	34.8	25.20	.72

Sources of Revenue

A study of farm income from 1948 to 1958 showed that cattle, field crops and hogs were the three main enterprises up to 1954. After 1954 a change was made to step up poultry production and to decrease revenue from field crops. This resulted in poultry becoming one of four main sources of revenue from 1955 to 1958. However, during the 11-year period the range in farm income from the various enterprises (with the average in brackets) was as follows: Cattle 33.3 - 75.9 (57.7) per cent; field crops 1.2 - 46.4 (23.9) per cent; hogs 2.7 - 16.1 (8.1) per cent; poultry 0.0 - 14.9 (5.0) per cent; and other sources 2.2 - 17.6 (5.3) per cent. In other words, livestock contributed 70.8 per cent of the farm income.

Capital Investment

The variation in capital investment from 1948 to 1958 (with the average in brackets) was as follows: Land and buildings 30.6 - 39.1 (34.4) per cent; machinery and equipment 23.8 - 31.7 (28.1) per cent; livestock 17.6 - 27.6 (21.8) per cent; and feed and supplies 12.7 - 19.5 (15.7) per cent. During the years 1953 to 1955 the percentage capital invested in livestock decreased somewhat while that for machinery increased.

Sale of Seed Grain and Breeding Livestock

One of the functions of the Substation is to produce good quality seed of recommended varieties for distribution. During the last 11 years seed of several new grain varieties was increased for this purpose. Some of the varieties were Saunders wheat; Larain, Beaver and Rodney oats; and Newal, Vantage, Gateway, Wolfe and Husky barley. During this 11-year period 279 buyers purchased 1089 bushels of Thatcher; 1887 bushels of Saunders; 2170 bushels of Larain; 3170 bushels of Beaver; 80 bushels of Montcalm; 740 bushels of Newal; 846 bushels of Olli and 380 bushels of Wolfe. Thus a total of 10,362 bushels were sold of these varieties.

Another function of the Substation is to encourage the production of good quality livestock. High quality herds of Hereford and Holstein cattle and Yorkshire swine were maintained throughout the years. Breeding stock sold during this period included 37 head of cattle and 13 swine.

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Selected Seed Grain and Breeding Livestock

One of the functions of the Substation is to produce good quality seed of recommended varieties for distribution. During the past 11 years seed of several new grain varieties was increased for this purpose. Some of the varieties were Saunders wheat; Larain, Beaver and Rodney oats; and Newal, Vantage, Gateway, Wolfe and Husky barley. During this 11-year period 279 buyers purchased 1089 bushels of Thatcher; 1887 bushels of Saunders; 2170 bushels of Larain; 3170 bushels of Beaver; 80 bushels of Montcalm; 740 bushels of Newal; 816 bushels of Olli and 380 bushels of Wolfe. Thus a total of 18,562 bushels were sold of these varieties.

Another function of the Substation is to encourage the production of good quality livestock. High quality herds of Hereford and Holstein cattle and Yorkshire swine were maintained throughout the years. Breeding stock sold during this period included 57 head of cattle and 13 swine.

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